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Minnesota
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University of
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St. Paul,
Minnesota

Warm Season Perennial Forage Grasses:

Big Bluestem and Switchgrass

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History and Ecology

Big bluestem (*Andropogon gerardi* Vitman) and switchgrass (*Panicum virgatum* L.) are among the few forage grasses which are true natives to North America.

Along with porcupine grass (*Stipa spartea* Trin.), Indiangrass [*Sorghastrum nutans* (L.) Nash], prairie dropseed (*Sporobolus heterolepis* A. Gray), and little bluestem [*Schizachyrium scoparium* (Michx.) Beauv], these grasses were major constituents of the northern tall grass prairies of the Great Plains and were a food source for buffalo and other wildlife (Figure 1). The tall grasses were the climax vegetation in the region and persisted under infrequent defoliation and burning, which killed competing perennial plants. Long-term growth of the tall grass prairies resulted in fertile soils high in organic matter.

Big Bluestem Plant: Inflorescence; root system; and seed.

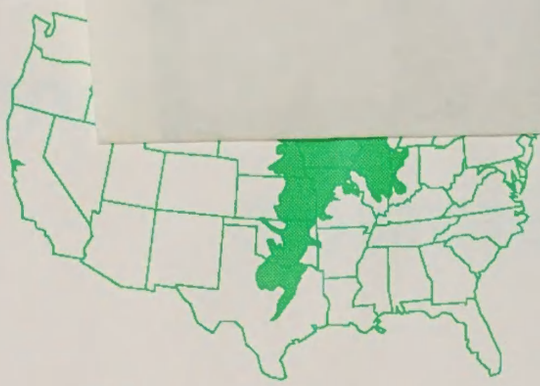


Figure 1. North American Tallgrass Prairie.

During the 1800's the region was settled by pioneers who began to produce crops and graze livestock. The high soil fertility and favorable climate made the region well-suited for agriculture, especially for the production of annual grain crops. In most pastures, native grasses were replaced by cool season grasses such as Kentucky bluegrass (*Poa pratensis* L.), smooth bromegrass (*Bromus inermis* Leyss.) and quackgrass [*Elytrigia repens* (L. Nevski)]. These grasses were initially introduced into North America from Europe.

Since settlement, more than 99% of Minnesota's original prairie has been destroyed and only about 200,000 acres remain. Warm season grasses warrant consideration for additional use throughout the Midwest. These uses include forage and biomass production, wildlife habitat, roadside revegetation, erosion control, and landscape beautification.

vs. Cool
es

Big bluestem and switchgrass are called warm season grasses because they grow best at air temperatures of 85 to 90°F. Cool season grasses such as Kentucky bluegrass and smooth bromegrass grow best at 65 to 75°F. Warm season grasses start growing at temperatures near 55°F; growth of cool season grasses begins at about 40°F. Warm season grasses have greater water use efficiency than cool season grasses and are more productive during drought. Because they initiate growth in late spring, more soil moisture is available for summer production.

Warm and cool season grasses have contrasting patterns of yield distribution. Warm season grasses produce more than 60% of their yield in mid-summer (Figure 2), while cool season grasses have their greatest production in spring and fall. Cool and warm season grasses can best be used in grazing systems which combine separate pastures of each grass type. Including warm season grasses in a grazing system permits resting cool season grasses in mid-summer which improves their vigor and enhances forage production in late summer and fall. Cool season grasses can be grazed in the spring and fall and the warm season grasses during mid-summer.

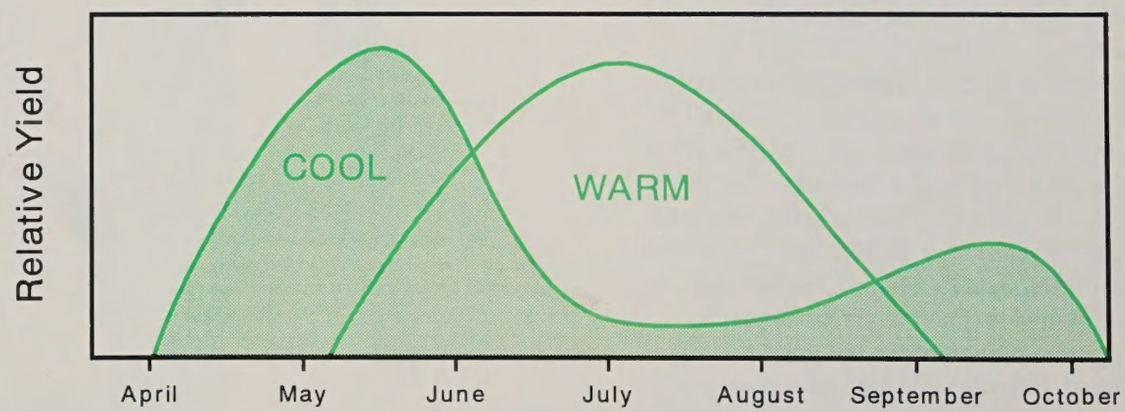


Figure 2. Seasonal Distribution of Cool and Warm Season Grass Production.

Description and Adaptation

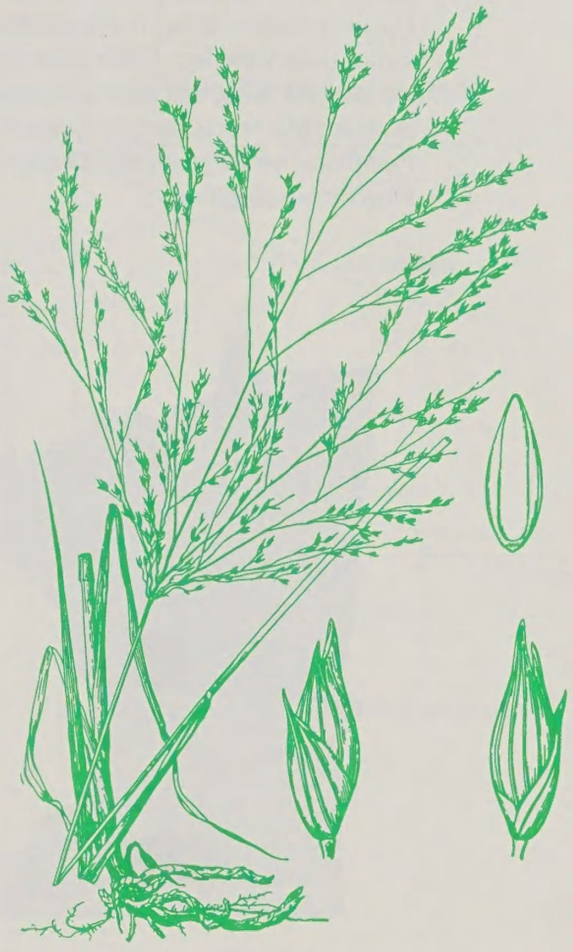
Mature big bluestem is 3 to 6 feet tall. It has long white hairs on the upper leaf surface near the base of the blade. Lower leaf sheaths and blades are sometimes hairy. Big bluestem is bluish in color during most of the summer, but is often reddish purple at maturity. Seedheads consist of two to three racemes which arise from a common joint of the seed stalk and resemble a turkey's foot. Big bluestem has coarse stems supporting leaves and inflorescences. Although big bluestem has short rhizomes, plants grow in bunches.

Mature switchgrass is similar in height to big bluestem with leaves 1/4 to 1/2-inches wide and 6 to 18 inches long. Leaf blades and sheaths are smooth and without hairs except at the base of the leaf blade. Switchgrass plants appear bunch-like if not defoliated, but the short underground stems (rhizomes) can produce a loose sod under grazing. Switchgrass has a large spreading panicle inflorescence borne on coarse stems. In general, switchgrass matures 1 to 2 weeks earlier than big bluestem.

Adapted varieties and ecotypes of big bluestem and switchgrass are very winter-hardy and will persist in most areas. They grow best on fertile, moist, well-drained soils and can survive severe drought. Big bluestem is more drought tolerant than switchgrass while switchgrass is more tolerant of poorly drained conditions. Established stands of switchgrass have been reported to survive 40 days of flooding.

Warm season grasses grow best on fertile soils but once established can persist on soils with pH of 4.0 to 8.5 and very low levels of extractable phosphorus. However, adequate soil phosphorus is essential for establishment.

Big bluestem and switchgrass are tolerant to atrazine and other selective chemicals used to control cool season grasses. Therefore, they can be used in waterways, terraces, and field borders for soil conservation and wildlife habitat in row-crop production fields.



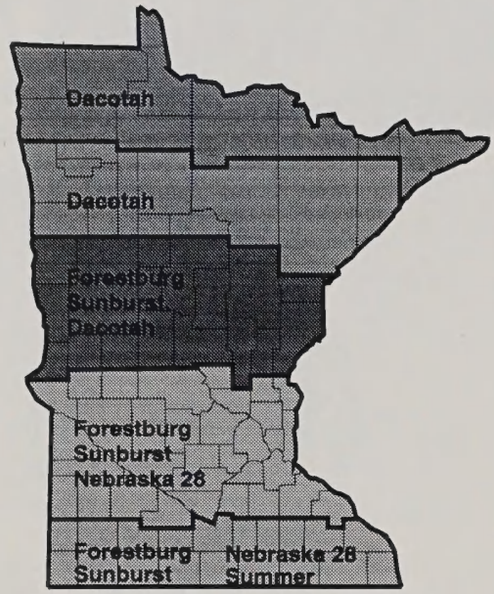
Switchgrass Plant: Inflorescence; root system; and seed.

Varieties

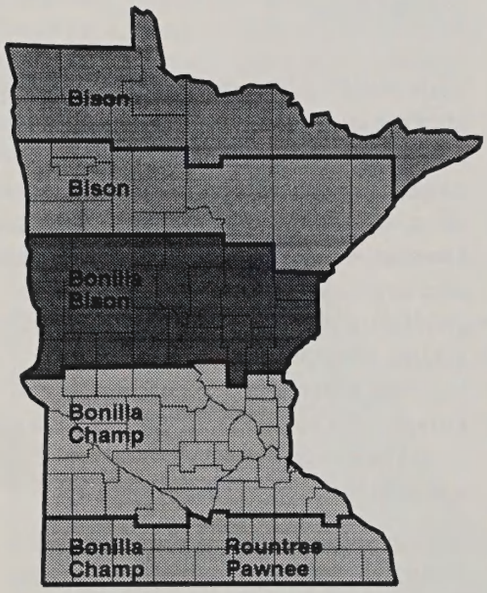
Varieties of big bluestem and switchgrass vary in origin and maturity and should be selected for region of adaptability (Figure 3). Varieties adapted to southern regions are later maturing, taller, and produce higher yields of forage; however, they will not always produce mature seed and may be winter injured under defoliation stress if grown and harvested by grazing or haying in northern regions. Varieties adapted to the north which are grown in the south mature early, are shorter, have low forage production, and are susceptible to leaf and stem diseases.

Bonilla and *Sunnyview* big bluestem and *Forestburg* and *Sunburst* switchgrass are newer varieties. They mature early and are adapted to southern and central regions of Minnesota. *Bison* big bluestem and *Dacotah* switchgrass are recently released varieties

adapted to northern regions of the state. *Dacotah* is more drought tolerant than other switchgrass varieties. Other varieties which are later maturing and more adapted to southern Minnesota include *Summer* and *Pathfinder* switchgrass, and *Champ* and *Pawnee* big bluestem.



Switchgrass



Big Bluestem

Figure 3. Varieties adapted to regions of Minnesota.

Forage Yields and Quality

Big bluestem and switchgrass have good summer yield potential. Forage yields average from about 1 to 5 tons per acre depending on soil fertility and moisture, location, variety, and harvest management. Producers can greatly influence yield by nitrogen fertilization and harvest management. For example, a single harvest of unfertilized stands will often result in yields of only 1 to 2 tons per acre. In contrast, yields would likely be doubled with application of 75 pounds per acre of nitrogen fertilizer and two harvests per season.

As warm season grasses mature, forage yield increases while forage quality decreases (Figures 4 and 5). A large part of that yield increase is due to development of the stem which is lower in nutritive value than leaves. From June to August, forage crude protein concentration decreases from 1 to 2 percentage units per week while digestibility declines 2 to 3 percentage units per week. In contrast, fiber levels which are negatively related to intake increase 1 to 2 units per week.

Figures 6 and 7 illustrate the nutrient fraction of leaf and stem components for one variety of big bluestem and switchgrass.

Decisions on when to harvest warm season grasses for forage are a compromise between forage yield and forage quality. If used for hay, warm season grasses are usually cut once (at early heading near end of the season) or twice (at boot and vegetative stages) per year. Cutting only once at maturity results in greater yields, but lower forage quality than cutting twice at less mature stages. Figures 8 and 9 illustrate the yield and quality under one and two cut harvest regimes for adapted varieties of big bluestem and switchgrass.

If unfertilized and harvested after heading, the forage quality of warm season grasses may sometimes be inadequate to meet the needs of some classes of livestock. For example, a 600 pound steer with a 1 pound per day gain rate, requires dietary crude protein and energy (TDN) of 9% and 58%, respectively. Mature forage harvested in late August may result in poor animal performance.

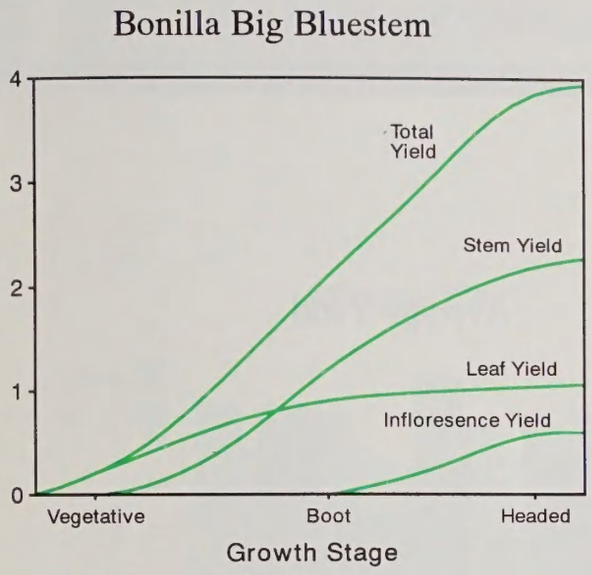


Figure 4. Dry matter yield and composition with maturity.

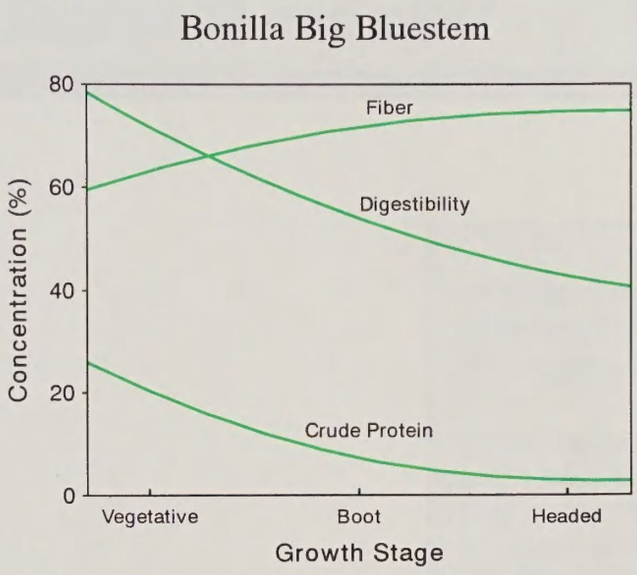


Figure 5. Change in whole plant forage quality with maturity.

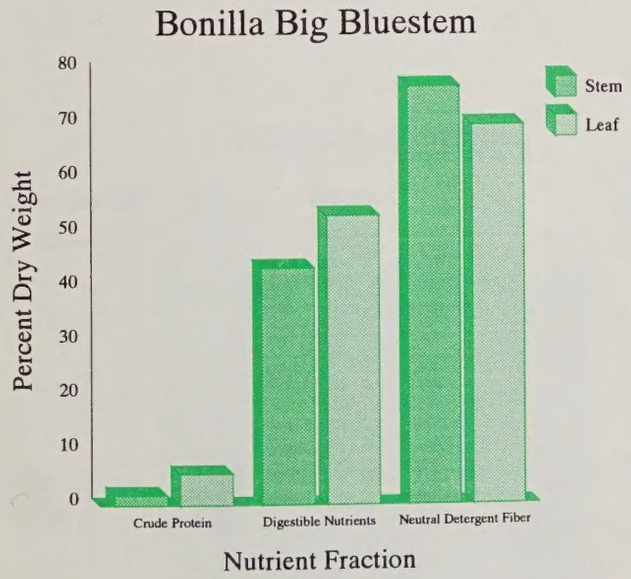


Figure 6. Quality of leaf and stem fractions of big bluestem.

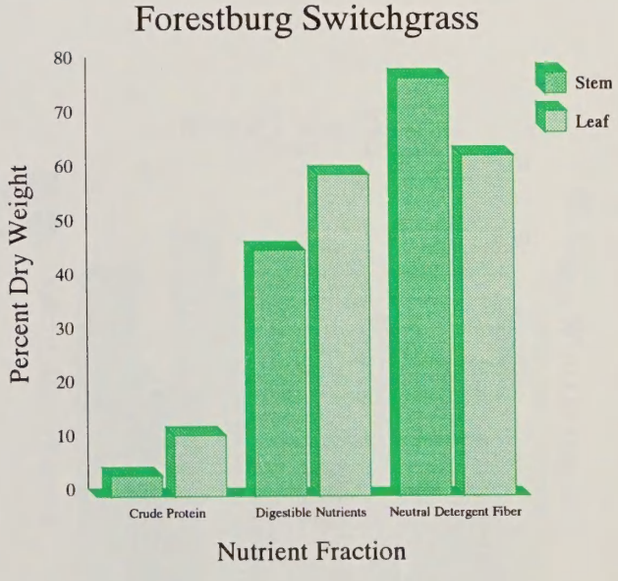
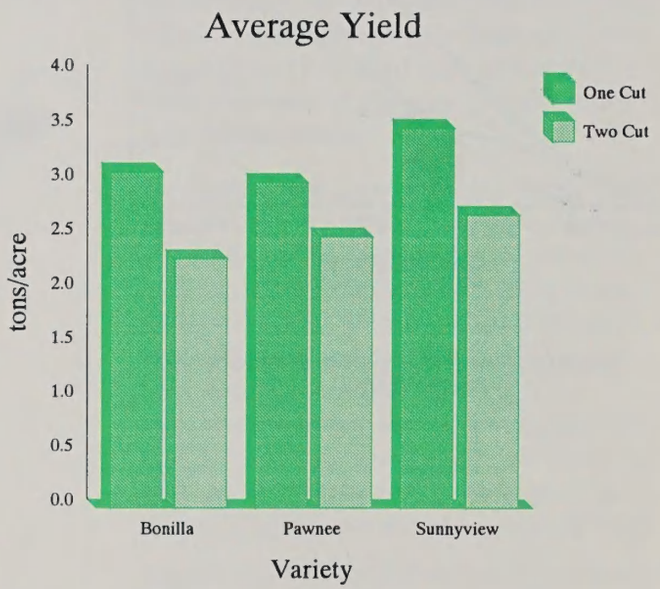


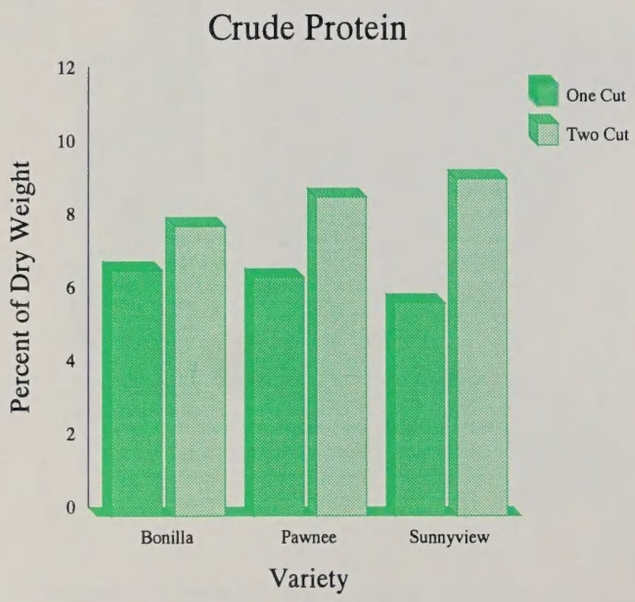
Figure 7. Quality of leaf and stem fractions of switchgrass.

Effects of Harvest Regimes on Forage Yield and Quality of Big Bluestem

One Cut=one harvest per year at heading.

Two Cut=two harvests per year, first harvest at boot or early heading and second harvest in August.





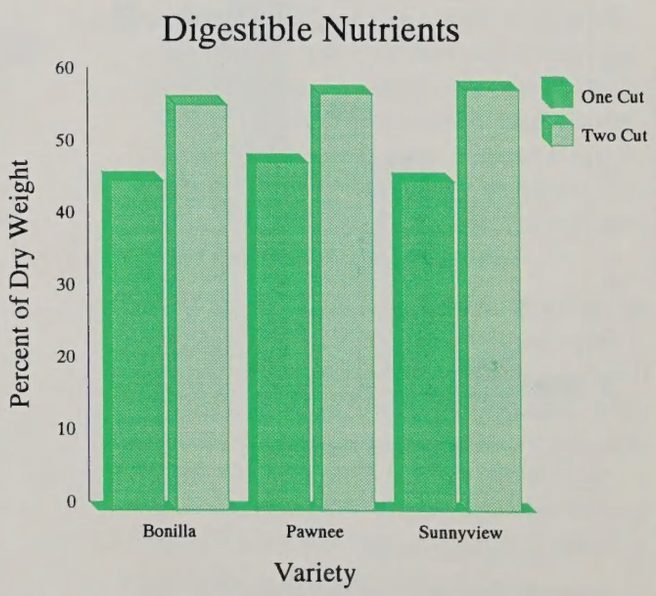
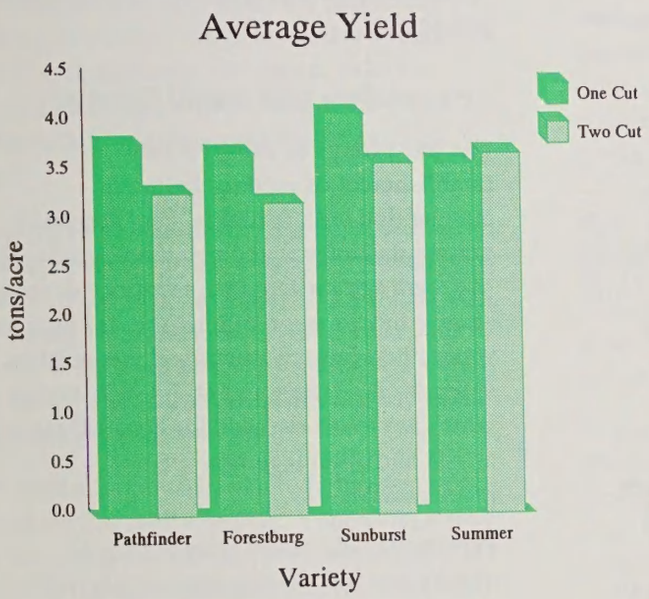


Figure 8.

Effects of Harvest Regimes on Forage Yield and Quality of Switchgrass



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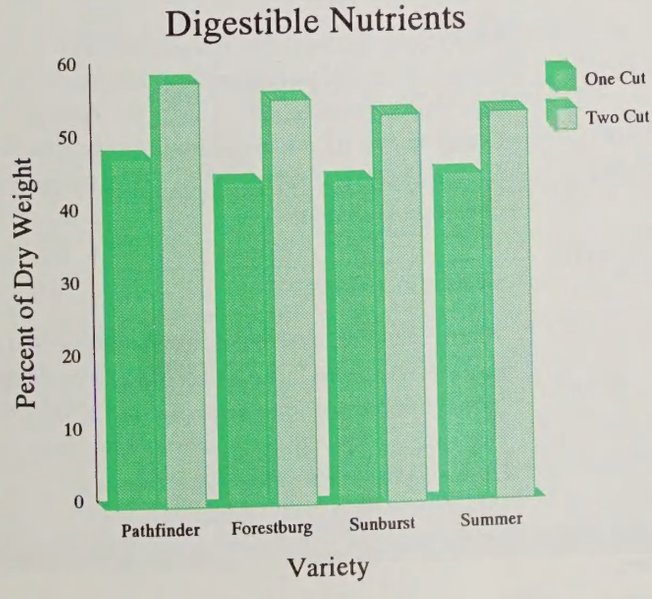

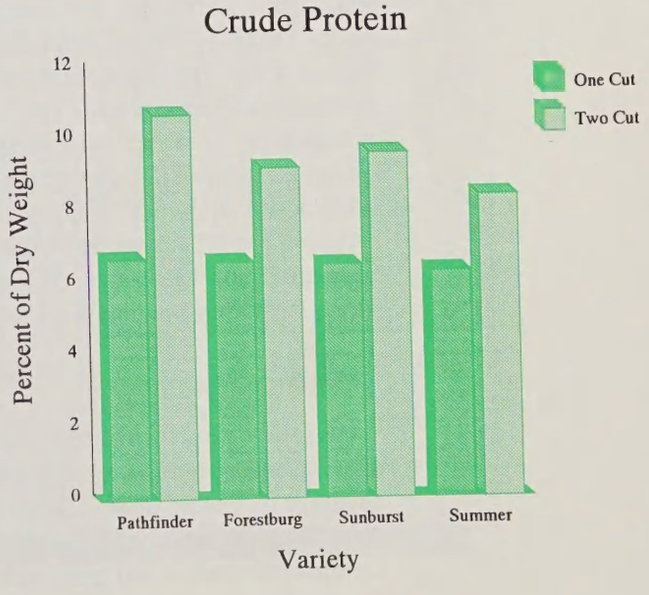

Figure 9.

How to Manage Big Bluestem and Switchgrass

Establishing Warm Season Grasses

Warm season grasses establish slowly and are poor competitors with cool season grasses and annual weeds. If competing plants are controlled, good stands of warm season grasses can be obtained in the seeding year and grazed in the year following seeding. With competition from weeds, it may be 3 to 4 years before the stand is ready to use. Seedbed preparation, planting depth, and weed control are critical to the establishment of warm season grasses.

•Seedbed Preparation:

A firm and smooth seedbed which insures good soil-seed contact and shallow seed placement is very important. Loose and uneven seedbeds are a major cause of poor stands. Your shoes or boots should sink only about 1/2-inch into a properly prepared seedbed. Conventional tillage in the year before seeding followed by shallow disking, harrowing, and packing before seeding are desirable. Cultipacker seeders or press-wheel drills with depth bands are ideal to achieve proper seed placement, distribution, and seedbed firmness. Successful seedlings can also be achieved by broadcast seeding at an increased seeding rate and by rolling or cultipacking before and after seeding. Warm season grasses can also be successfully seeded using no-till equipment that provides good soil-seed contact and proper depth placement. Suppression of weeds and sod for at least 6 weeks following seeding is essential.

•Planting Depth:

Seeds should be placed at a 1/4 to 1/2-inch soil depth. Seeds sown on the soil surface without coverage or greater than 1/2-inch deep have little chance of developing into seedlings. Cultipacker seeders and grassland drills are designed to insure shallow seed placement; however, standard small grain drills require seed agitators, readjustment of seed delivery tubes, and depth bands mounted on disc openers to insure proper seed distribution and placement.

•Vegetation and Weed Control:

The most frequent cause of slow establishment or seeding failure is competition with perennial cool season grasses and annual and perennial weeds. Big bluestem and switchgrass seedlings develop slowly and are poor competitors for light and water; therefore, competing plants must be suppressed. Companion crops such as oats, which are routinely used for establishment of alfalfa and other legumes, are not recommended.

Perennial cool season grasses such as quackgrass and smooth bromegrass and perennial weeds such as thistles should be treated in the year before seeding with products such as *Roundup* or *2,4-D* (See Minnesota Bulletin AG-BU-3157-S, *Cultural and Chemical Weed Control in Field Crops*). Severe grazing followed by tillage can destroy existing vegetation but herbicide application may still be required.

Mowing or grazing can reduce weed competition following seeding although repeated treatments are usually necessary. Graze or clip to a 4-inch height when weeds form a canopy. Overgrazing will damage developing stands.

•Seeding Time:

Warm season grasses should be seeded from late April to June 1. Later seedings often have less available soil moisture and are slower to establish. Consequently, stands are often thinner, yield less, and have more weed infestation than early seedings.

•Seeds and Seeding Application Rate:

Buy certified seed of adapted varieties. Since varieties and species mature at different rates, management for forage production is easier if varieties and species are not mixed in the same field.

Switchgrass seed has a hard and slick seed coat and can be dispensed through most standard seeding equipment. Big bluestem seed has appendages with fine hair which causes the seed to bridge in most conventional seeding equipment. Therefore, unless a special grassland drill is available, "debearded" big bluestem seed should be used.

Seeding rates should provide 30 to 60 live seeds per square foot. Therefore, switchgrass is seeded at 5 to 8 lbs of pure live seed per acre while big bluestem is seeded at 10 to 15 lbs of pure live seed per acre. The higher rate should be used for broadcast seedings and the lower rate using a grassland drill.

There is a large variation in germination rate and purity of seed supplies. Therefore, it may be necessary to increase your seeding rate to provide the recommended rates of pure live seed. Read the seed tag to determine contents of the bag and seed quality. From the tag you can obtain information on **% germination**, **% inert material**, **% other seed**, and **% weed seed**. With this information you can compute the **percent pure live seed** and **pounds of bulk seed** required using the steps in Figure 10.

•Soil Fertility:

Warm season grasses can be productive on low fertility soils, but fertilization will increase stand vigor and yield. Greatest responses have been observed with nitrogen and phosphorus fertilization. Because nitrogen fertilization promotes growth of weeds, it is generally not recommended at establishment unless the chances of weed competition are low.

For established stands being grazed or hayed or to increase plant vigor, apply 75 - 100 lbs nitrogen per acre when growth in the spring has reached 4 to 6 inches or the soil temperature reaches 60°F. Applications of greater than 100 lbs of nitrogen per acre are not profitable.

In general, soil pH correction to 6.0 and phosphate and potash fertilization are recommended when soil test levels are low. In areas of low soil phosphorus such as western Minnesota, a rule of thumb is to apply nitrogen and phosphate in a 3:1 ratio; i.e., for a nitrogen application of 90 lbs per acre, apply 30 lbs of phosphate. On soils low in potassium, application of 40 to 50 lbs of potash may be beneficial.

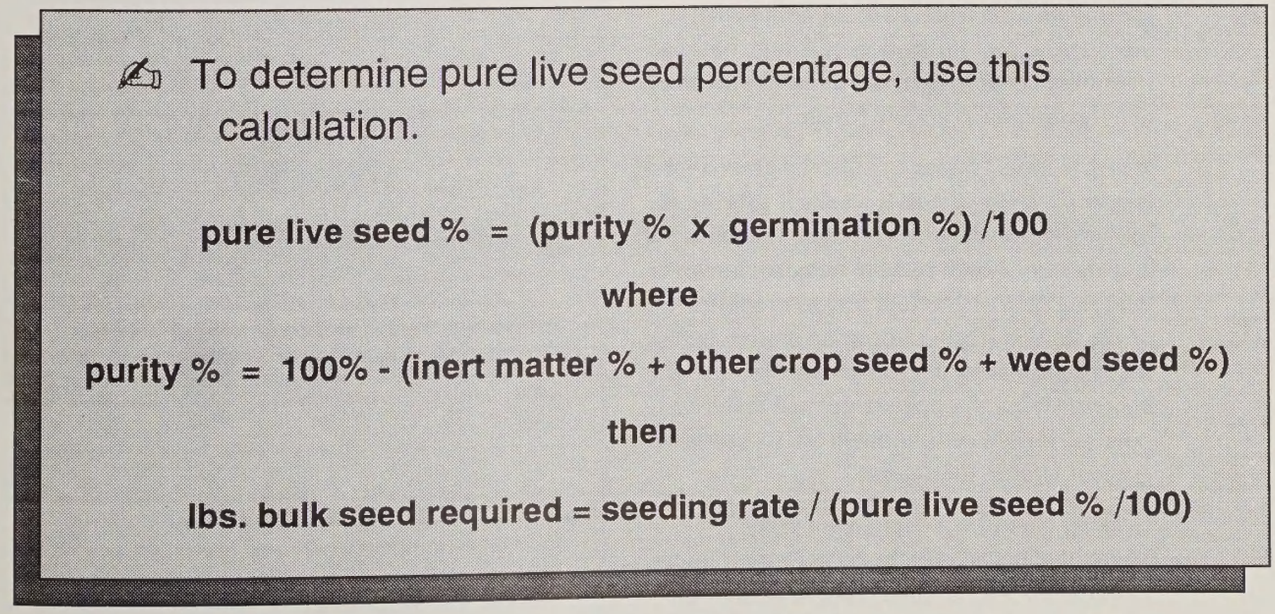

Figure 10. Steps for computing seed quality and seed requirements.

ANIMAL RESPONSE TO GRAZING

Livestock grazing big bluestem and switchgrass have averaged gains of over 1.5 pounds per day. In recent research at Morris, Minnesota steers rotationally grazed for about sixty days on big bluestem and switchgrass and gained from 0.4 to 2.8 pounds per day. Average liveweight gain per acre was 275 pounds per acre. The low average daily gains which sometimes occurred were due to grazing the grasses after heading when forage was very stemmy and contained low nutrient concentrations.

Grazing Management

Grazing should be early and stocking density high enough to use the grasses before stems develop. Rotational grazing is recommended to reduce trampling and enhance utilization. Grazing should be initiated when grass is about 12 inches tall and grazed to a 6-inch stubble height in a rotational grazing system. A 4 to 6 week rest period allows grasses to recover and light regrazing can occur. The duration of grazing of an individual paddock or field should be limited to 1 to 2 weeks.

Short-duration intensive grazing with animals grazing an area from 12 to 24 hours will provide the best utilization of forage because trampling is minimized and animals are forced to consume the available forage.

Warm season grasses can also be grazed for a longer duration of 6 to 8 weeks if grazing is initiated when the grass is about 12 inches tall and an 8 to 12-inch stubble remains; however, with this type of grazing, forage in some areas of the field is likely to become mature before it can be consumed. This mature forage will be very stemmy, unpalatable, and result in poor performance if animals are forced to graze it later in the season.

Grazing should not occur after early September because of the risk of winter injury. Leaving an 8 to 12-inch stubble in the fall allows the plant to store carbohydrate in the crowns and roots and insures vigorous plant growth in the spring.

Hay Management

Big bluestem and switchgrass forage yield and quality are related to stage of maturity at harvest. Producers desiring high quality forage should harvest at boot stage (immediately before inflorescence emergence) which should allow two harvests in most seasons. Harvest at heading will often result in greater yields but forage quality will be lower. For hay production, grasses should be harvested leaving a 6-inch stubble.

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Availability

For more information about warm season grasses, or how to obtain a copy of this publication, contact the local Extension Service or Natural Resources Conservation Service (formerly Soil Conservation Service) office in your county.

Information in this publication is designed to help producers establish and manage warm season grasses - particularly Big Bluestem and Switchgrass varieties adaptable for Minnesota.

The recommended varieties of warm season grasses can be used for forage, biomass production, wildlife habitat, roadside vegetation, erosion control and landscape vegetation.

The information is provided by the Minnesota Extension Service and the U.S. Department of Agriculture's Natural Resources Conservation Service, in cooperation with Minnesota forage producers.